

- Fig. 3. Papillæ of the mucous membrane of rumen (natural size).
 4. Outline of liver (reduced).
 5. Larynx from behind.

PLATE VII.

- Fig. 6. Male generative organs. The outline of the bladder is seen through the peritoneum. The lettering applies as follows:—*a a*, testicles; *b b*, vasa deferentia; *c c*, vesiculæ seminales; *d d*, Cowper's glands; *e*, intrapelvic portion of urethra; *f*, bulb of urethra; *g g*, erectores penis; *h h*, retractores penis; *i*, penis; *k*, vesicula prostatica; *l l*, ureters.
7. Intrapelvic portion of the urethra laid open, showing the single opening common to the two seminal ducts: *a*, muscular fibres; *b*, erectile tissue.
8. Glans penis.

On the Geographical Distribution of the Gulls and Terns (*Laridæ*).
 By HOWARD SAUNDERS, F.L.S., F.Z.S.

[Read April 18, 1878.]

To those who have only a general knowledge of the family of the Laridæ, which comprises the subfamilies *Sterninæ* (Terns), *Rhynchopsinæ* (Skimmers), *Larinæ* (Gulls), and *Stercorariinæ* (Parasitic Gulls), it may seem that there is but little to be said respecting the geographical distribution of a group whose conditions of existence being almost entirely dependent upon water, and, in the majority, marine, are therefore particularly favourable to dispersion and general distribution, and opposed to the development of specialized forms. A closer investigation of the subject shows, however, that whereas some members of the family have an exceedingly wide range, there are, on the other hand, many remarkable and isolated forms which, for reasons as yet unknown to us, are restricted to very narrow geographical areas. In some instances it is not difficult to trace the connexion with the other members of the same group; and in other cases the existing gaps between closely allied species may be explained, with a fair show of probability, by the alterations which are known to have taken place in the geographical features of the area now inhabited. But even then it must often be a matter for wonder that birds of such powers of flight should consent (if I may use the word) to remain within such confined limits, when the causes which formerly might have proved a barrier to their extension have for ages disappeared.

There are, however, several remarkable instances of this apparently voluntary restriction which are not to be accounted for by deficiency or variation in food, nor even by climatic changes. These cases are more frequently to be found amongst the Gulls (*Larinæ*), which, being to a great extent omnivorous, are the scavengers of the shores; whilst the Terns (*Sterninæ*) obtain their sustenance almost entirely from the sea or from inland waters, and are also, by their slender shape and length of wing, obviously adapted for long and sustained flights. Yet even amongst the Terns there are several remarkable cases of isolation and restriction; and it is in this group that we are more especially enabled to trace several interesting links in the chain of dispersion accompanied by gradual variation.

It is not necessary to occupy more space with preliminary remarks; but I may observe that my investigations during the past seven years lead me to accept about 53 recognizable species of Terns and Skimmers, 50 of Gulls, and 6 of Skua Gulls, a considerable reduction from the 160 species upheld by Bonaparte in his latest revision of the Longipennes. Even of the accepted species, there are, however, several which are little more than climatic varieties, and they will merely be alluded to in the course of my remarks upon the general distribution of the groups of which they form part. Nor is it my intention to lay any stress upon solitary and accidental stragglers to places far removed from their normal habitat, especially where these apparitions are those of immature birds, which generally wander far more than adults—my object being to bring forward the broad features of the geographical distribution of the members of this family, without dwelling upon trifling and irrelevant exceptions.

For convenience of treatment it will be better to commence with the *Stercorariinæ*, or Skua Gulls (*Lestridinæ*, Illiger), which inhabit the Arctic and Antarctic seas. Two out of the four northern species are very closely allied. The most Arctic in its habitat, *Stercorarius parasiticus* (L.), commonly known as Buffon's Skua, being an elegant long-tailed form of the stouter and shorter-tailed species *S. crepidatus* (Gm.), which, to avoid mistakes, I call Richardson's Skua, a vernacular name originally applied to a melanic variety of the species, but adopted as the least liable to cause confusion. The former breeds throughout the regions to the north of the Arctic circle, straying southward in winter, both in the Atlantic and Pacific. Its extreme range on

record being that of a young bird obtained between the Philippines and the Sandwich Islands, to which Bonaparte gave the name of *Lestris hardyi*; this example is in the Berlin Museum, where I have recently examined it. Richardson's Skua has a more southern breeding-range, nesting as far down as the Orkney and Shetland Islands, whence it goes in winter as far as the Cape of Good Hope, and in all probability up the east coast of Africa to Persia and the coast of Scind, being apparently the species described from there by Mr. A. O. Hume as *S. asiaticus*. On the Atlantic side of America it goes to Rio Janeiro, being apparently the species described by Solander, in his unpublished MS. in the British Museum, under the names of *Larus fuliginosus* and *L. nigricans*; and it probably visits the Pacific coasts, as a solitary example which I refer to this species was obtained by Mr. Buller in the Province of Wellington, New Zealand. Both these species possess great powers of flight, so that they are able to pursue and rob, not only the smaller Gulls, but also the Terns; and as the latter are found in an uninterrupted succession throughout the whole of the indicated range, there is at once an assignable reason for great extension in the range of the latter of these two Skuas. A larger and stouter species, with broad-pointed central tail-feathers, *S. pomatorhinus*, with an Arctic breeding-range nearly identical with that of *S. parasiticus*, has nearly as extensive a southern range as *S. crepidatus*, immature birds having occurred in West Africa down to Walwich Bay, and once at Cape York, North Australia; whilst in the North Pacific it has occurred at the Prybilov Islands, and the 'Challenger' Expedition obtained a fine adult specimen in Inosima, Japan. In powers of flight this bird is nearly if not quite equal to its two congeners, and the same causes probably influence its distribution.

But now, on leaving these three perfectly distinct species, we come to three others whose distinctions are comparatively trifling, at the same time that the gradations of differences and geographical distribution are very interesting. The northern species, *S. catarrhactes*, whose breeding-range stretches from the coast of Norway, the Faroes, and Iceland, away through the Nearctic region and the Pacific, appears to be nowhere numerically abundant, and is fast becoming exterminated in Europe. It is a bold, predacious, but somewhat heavy bird, addicted at times to the slaughter of lambs, and deriving its main sustenance from plundering the Gulls, especially the Kittiwake (*Rissa tridactyla*), upon which, more-

over, it seems to prey; for Capt. H. W. Feilden found the bones and feathers of that species in the stomachs and castings of the Skuas at the Faroes. In winter it ranges down to the Straits of Gibraltar, and perhaps a little further; and on the Pacific side it has *once* been obtained, as recorded by Lawrence, at Monterey, California. It would probably have little chance of overtaking a Tern, but it is quite fast enough to tyrannize over any of the smaller Gulls; and it is interesting to observe that its range coincides with the winter range of the Kittiwake. As already shown, it has occurred in California; but descending that coast, we find no trace of a large Skua until we enter the fish-abounding, and therefore gull-frequented, waters of Humboldt's Current, which cools the coasts of Chili and Peru throughout a width of about 300 miles, and sweeps outwards to diminish the natural heat of the equatorial Galapagos Islands. In these productive waters is found a large Skua, *S. chilensis* (*vide* P. Z. S. 1876, p. 323, pl. xxiv.), separable from the northern *S. catarrhactes* by its brighter and more chestnut underparts and axillaries—differences which are constant, although it is true that they are merely those of colour. Its bill is perhaps a trifle more slender than that of the northern bird, a point which should be borne in mind, because on passing through the Straits of Magellan, where this species appears to stop, we come at once to another large Skua, *S. antarcticus*, which, although in such close geographical proximity to *S. chilensis*, yet differs far more from it than *S. chilensis* does from *S. catarrhactes*! The Antarctic Skua ranges from the Falkland Islands down to the edge of the pack-ice, the shores of New Zealand, and up to Norfolk Island, and thence by way of the chain of Kerguelen Island, St. Paul's Island, the Crozets, &c., it reaches the Cape of Good Hope and, as a straggler, Madagascar. From the Cape it works round by Tristan d'Acunha and the South Atlantic islands, till the chain is completed at the Falklands again. *S. antarcticus* is a uniformly dusky bird, with stronger and shorter bill than either of its near relatives; but it is interesting to observe certain slight variations in the chain even in the selfsame species. The largest birds are from the Southern Ocean, between New Zealand and the Cape of Good Hope, and they are also the duskiest in colour; those from the South Atlantic are smaller, and have a tendency to a pale frill of acuminate feathers, similar to that which is more or less marked in all the other Skuas; whilst the three individuals obtained by the 'Erebus' and 'Terror'

Expedition from the edge of the pack-ice, now in the British Museum, are wonderfully bleached and weird-looking birds. On reading the account given by Dr. Kidder respecting the habits of this species at Kerguelen Island, where it seems to avoid water and to prey principally upon the flesh of other birds, it is rather remarkable that it should have varied so little; but so far as our present defective knowledge of distribution goes, the evidence seems to point to the North Pacific as the district whence the members of this group originally sprung. I am quite prepared to learn that *S. chilensis* goes as far as the Galapagos, which would considerably narrow the gap which separates it from *S. catarractes*. *S. antarcticus* is a still more specialized offshoot, entirely absent from the great space which lies between New Zealand and the western shores of South America, and probably restricted from ascending the eastern coast of that continent and the coasts of Africa by the absence from those districts of the gulls upon which it can directly or indirectly prey.

In the North Pacific, again, where the Aleutian Islands form a broken chain between Alaska and Kamtschatka, and enclose Behring's Sea, is found a distinct and very local species of Kittiwake Gull (*Rissa brevirostris*, Brandt), having a short stout bill, rudimentary hind toe, a grey mantle much darker than in the Common Kittiwake, and orange legs and feet, but which calls for no further remark. Over the same area is found the Common Kittiwake, *Rissa tridactyla*, a species which ranges throughout the whole Arctic and Subarctic regions, descending on the Atlantic coasts somewhat further than on those of the Pacific. The vast majority of individuals throughout this area are precisely identical; but *some* of the *Alaskan* examples have a minute but distinctly formed hind toe, and even a nail, although this peculiarity is not always equally developed on both feet of the same bird! Inasmuch as every other member of the family of the Laridæ, except *Rissa*, has a fully developed hind toe, it is tolerably evident that in *Rissa* it has for some reason become obsolete; and as the survivors of the hind-toed *Rissæ* are only found round Alaska, it would appear probable that the North Pacific in this case also is the point of dispersion and variation for this genus.

Amongst the typical Gulls there are only two species, *Larus glaucus* and *L. leucopterus*, which have white primaries devoid of dark markings or "pattern"; and these two range throughout the whole Arctic and Subarctic region, including the North Pacific

from Alaska to Japan. It is, however, only in the North Pacific and North-western America that we find *L. glaucescens*, a gull of similar dimensions but with faintly barred primaries, which give it in effect the appearance of a washed-out Herring-gull (*L. argentatus*). It is a perfectly recognizable species, but it is clear that it forms a connecting-link between these two groups; and as it is well-established that the Herring-gulls which are resident furthest north are lighter in colour than southern examples, it is not difficult to trace out the gradual diminution of colour through *L. glaucescens*, till the total loss of it is reached in *L. glaucus* and *L. leucopterus*. In the Herring-gull group, again, all the forms—call them species or varieties—are found in the North Pacific. It is there that we meet with *L. argentatus* of our islands, Western Europe, and North America, as distinguished by its pale flesh-coloured legs and pale eyelid from *L. cachinnans*, with its slightly darker mantle, yellow legs, and bright brick-red eyelids, which takes the place of *L. argentatus* in the Mediterranean, over the steppes of Russia and Siberia, and coasts of Asia, and reaches to the Pacific seaboard of China. *L. affinis*, Reinhardt, with a yet darker mantle and wings, which, however, still show a distinct pattern in their outer primary feathers, is also to be found in the North Pacific. The explorations of Messrs. Seeborn and Harvie Brown on the Petschora have shown us that this last species merely visits Northern Europe and Siberia to breed at a time when there is an almost continuous sunshine, whilst the rest of the year is passed in the brilliant atmosphere of the Red Sea and the coasts from thence to India. Bearing in mind the gradual increase in intensity of colour in proportion to the amount of continued sunshine experienced by all these gulls, and the increasing pallor amongst the species which mainly inhabit the north, it seems impossible to avoid the deduction that many of these varieties which we agree to call species are almost entirely due to climatic influence. Of the three species named, two are, however, exclusively Palæartic; but on the American side, from Vancouver's Island to Lower California, is found another species, *L. occidentalis*, Audubon, a gull with a very dark mantle, no pattern on the outer primaries, and a short stout bill; this is an exclusively American form, but it is clearly a member of this group.

With the same range as *L. occidentalis*, and restricted, like it, to the western side of the North Pacific, is found *L. californicus*,

Lawr., the largest member of the group of which *L. zonorhynchus*, Ord, is its nearest ally in the Nearctic region ; and again, over a similar area is found *L. brachyrhynchus*, Richards., the close ally and representative in North-western America of *L. canus* of the whole Palæarctic region from Europe to Japan. These three species seem to keep to their respective sides of the North Pacific ; and if we except stragglers of *L. californicus* and *L. zonorhynchus* to Japan, and of *L. canus* to Labrador, these inhabitants of the Nearctic and the Palæarctic regions do not appear to overlap ; nevertheless the North Pacific is the only area within which they are *all* found, and seems in this case also to be the point of dispersal. This brings us to the consideration of another natural group, the members of which occur throughout the whole of the Pacific, both north and south, but more particularly in the latter.

In the typical Gulls the barred tail is a mark of immaturity, and the hood is usually the sign of breeding plumage ; but there is a group in which these conditions are partially or entirely reversed. The coasts of China and Japan are frequented by *L. crassirostris*, Vieill., a medium-sized gull, which has a slight tendency to a brownish hood when young, but which in the *adult* state has a pure white head and underparts, a dark grey mantle, and a tail crossed by a broad black bar. On the Californian side is found *L. heermanni*, of about the same size, with a still more distinct hood in the immature stage, with more black on the tail, and underparts of a sooty grey colour, which fades away on the head into a pale grey in the fully adult. Yet further south, on the coasts of Peru and Chili, is *L. belcheri*, Vigors, a stout-billed gull, with a very marked hood in the early stage, but which when adult is much like *L. crassirostris*, except that its mantle is decidedly black. On the same coasts occurs a much slenderer and more elegant species, *L. modestus*, Tsch., with rather delicate tarsi ; this also has a decided hood when immature, but in the adult the dark grey of the underparts fades into a pale colour, and becomes almost white on the head and forehead. In the Galapagos archipelago, and nowhere else, is found a much stouter and coarser gull, *L. fuliginosus*, Gould, of a nearly uniform sooty hue, and bearing a hood in the adult as well as in the immature plumage. At the very extremity of the district, and extending some distance beyond it, ranging from the Straits of Magellan to the Falklands and South Shetland Islands, comes an aberrant species, of which it can only be said that its

affinities are more with this group than with any other. This is *L. scoresbii*, Traill, a gull with a remarkably short, stout, crimson bill, coarse feet, with somewhat excised webs, and a decided hood in the immature stage, whilst in the adult plumage the head becomes light coloured as in the rest of the group, from which, again, it differs in having a white tail like an ordinary adult gull. Passing to the extremity of the opposite side of the South Pacific, we find in Tasmania, and perhaps in New Zealand, a very large black-mantled gull with an enormously deep bill, *L. pacificus*, Lath., which, whilst in some points resembling the typical gull, *L. dominicanus*, to be considered next, has also a black band across the tail, which seems to indicate a relationship to the Pacific group. As regards *L. dominicanus*, Licht., it is an ordinary black-mantled, stout-billed gull, with an extensive range, reaching from New Zealand through Kerguelen and the intermediate islands to South Africa, and thence to South America on both sides nearly up to the tropic of Capricorn. So far as the southern hemisphere is concerned it stands alone; and perhaps its closest ally is the species *L. marinus* of the northern hemisphere, although the interval between their ranges is considerable. To avoid recurrence to the latter species, it may be as well to indicate its range here. The Great Black-backed Gull, *L. marinus*, the largest of all the family, is found throughout the greater part of the Palæarctic and Nearctic regions, more especially in the North Atlantic. In its wing-pattern it differs from any other large gull, and it is by no means closely allied to the Lesser Black-backed Gull, *L. fuscus*, which is also confined to the northern hemisphere, but has a less extended range, being only found along the shores of Europe, the Mediterranean, and the Red Sea and vicinity, not reaching to the Pacific seaboard of China, nor to the American side of the Atlantic. The latter is a long-winged elegant species, with yellow legs and a comparatively small foot, and is apparently closer to *L. affinis*, Reinh., than to any other.

Returning to the southern hemisphere, we find there a small and isolated group, all the members of which are very closely allied. In New Zealand the representative is *L. scopulinus*, Forst., a small gull with grey mantle, head, tail, and underparts white, and red bill and feet. In Australia, Tasmania, and New Caledonia it is replaced by *L. novæ-hollandiæ*, Steph., which merely differs from it in its slightly larger dimensions and a trifling variation in the pattern of the primaries. Then, without a link in the

chain, for no similar gull occurs on Kerguelen or any of the intermediate islands, a closely allied, but perfectly separable species, *L. hartlaubi*, turns up at the Cape of Good Hope. New Zealand also produces another species, *L. bulleri*, Potts, belonging to the same group, but varying rather more in its wing-pattern from *L. scopulinus* than that species does from the other two. *L. bulleri* seems to be rather a frequenter of inland waters, but all the others are *sea*-gulls, and, as has been observed, they form an isolated group. Bonaparte united them in the same subgenus with *L. gelastes* of the northern hemisphere; but the resemblance between them seems to me to be extremely superficial.

It is generally admitted that at one time Europe was united to Northern Africa at the Straits of Gibraltar, and again at Cape Bon in Sicily, the present Mediterranean sea being then divided into two great lakes. These barriers have long been broken down, yet there exists a gull which even now scarcely strays beyond the ancient limits of one of these inland lakes. This species is *L. audouini*, Payr., a long-winged bird similar to and nearly as large as a Herring-gull, but with black legs and a cherry-red bill crossed by a double transverse zone, its headquarters being in the vicinity of Corsica and Sardinia, and its occurrence has never been authenticated beyond Spain on the one hand, and Sicily on the other. There are scarcely two other species which have so circumscribed an area, and in a *sea*-gull this isolation is very remarkable. On the same waters, but with an extension of range as far as the Black, Caspian, and Red seas, and thence to Scind, is found *L. gelastes*, a slender gull, which, although devoid of a hood at all seasons, has close affinities with those species which bear a coloured hood in the breeding-season only, and which have next to be considered.

The typical Hooded Gulls are, with one exception, small or medium-sized birds; and as regards number of species, the group is better represented in the northern hemisphere than in the southern. Indeed the whole of the south-eastern portion of the globe can show but one solitary species, *L. phaeocephalus*, Sw., a South-African form with a pale grey hood, closely allied to, and, in fact, only just separable from, *L. cirrhocephalus*, Vieill., which inhabits the opposite coast of Brazil and the Rio de la Plata States, and has also, strange to say, been twice obtained on the Pacific near Lima. How it gets there is not known, the interval being absolutely unbridged, but the fact is undoubted. The African species is probably an offshoot of the American form, inas-

much as beyond the Neotropical district no other hooded gull is known to exist in the southern hemisphere. The Neotropical region, which has been so well worked out by Messrs. Sclater and Salvin, possesses three other indigenous species, two of which, *L. maculipennis*, Licht., and *L. glaucodes*, Meyen, only differ in a slight degree in the pattern of the wing-feathers. Their geographical distribution is, however, somewhat remarkable—the former ranging from South Brazil down to South-eastern Patagonia, where it stops, its place being taken from the Falkland Islands round to Chili by *L. glaucodes*. At the first glance, both these species much resemble our well-known *L. ridibundus*, L., of the Palæartic region, and they appear to be its southern representatives. Along the Andean range from Chili to Ecuador is found a much larger and handsome species, *L. serranus*, Tschudi, which breeds on the shores and islands of the Lake Titicaca and other lakes at a considerable elevation, only visiting the Pacific coast during the bad weather in the mountains. Any other Hooded species found in this region are merely winter visitants from the north, and the most abundant of these is *L. franklini*, a Subarctic species which breeds in the Fur countries, and ranges through North America west of the Mississippi, Mexico, and down the Pacific coast to Chili. Of the remaining two American species, *L. atricilla*, L., which has black primaries, inhabits the temperate and intertropical regions of the Atlantic and Pacific coasts; and *L. philadelphia* (Ord), (*L. bonapartii*, Rich.), ranges right across Subarctic America, descending both coasts, an immature straggler occasionally finding its way to the British Isles.

In the Palæartic region, *L. ridibundus*, L., is found throughout its whole extent, descending in winter as far as 15° N. lat. On the Indian coast it then impinges upon the domain of its stouter relative *L. brunneicephalus*, Jerd., a species which has its summer home in the lakes of the lofty tablelands of Tibet and Mongolia. Straggling along the Atlantic coast, but in the main confined to the Mediterranean and Black seas, is *L. melanocephalus*, Natt.; whilst that giant amongst the black-headed gulls, *L. ichthyaëtus*, ranges from the Mediterranean to the Bay of Bengal. Along the coasts and over the inland waters of China and Mongolia is found a very peculiar gull, *L. saundersi*, with which my lamented friend the late Mr. R. Swinhoe did me the honour of associating my name: it has remarkably slender feet and tarsi, resembling those of a marsh-tern, with a very stout and powerful bill. The smallest of all the gulls, *L. minutus*, Pall., ranges over the whole Palæ-

arctic region; and in its immature plumage, and in the pattern of its primaries when adult, seems to have no very close allies. In the Red Sea are found two species, the more specialized of which, *L. leucophthalmus*, is restricted to those waters, whilst *L. hemprichii* extends its range as far as Scind; like *L. atricilla* of America, they have black primaries, but there are no other points which indicate any special affinity. To sum up the evidence afforded by the distribution of the Hooded Gulls, it cannot be said to amount to much more than a general indication of an origin in either the Palæarctic or Nearctic region, probably the latter, as it is from thence that they have been diffused far as the extreme southern limits of the American continent.

The genus *Pagophila* calls for little remark; it contains but one species, the Ivory Gull, *P. eburnea*, and is a well-marked, coarse, and purely Arctic form, ranging from Novaya Zemlya to Spitzbergen and Baffin's Bay, but not being as yet recorded from any part of the North Pacific. Another purely Arctic form, the small Wedge-tailed or Ross's Gull, *Rhodostethia rosea*, Macgill., of which only thirteen specimens are known to exist, has a still more circumscribed range, and its headquarters appear to be Melville Peninsula, Boothia Felix, and perhaps the region between Spitzbergen and Franz-Joseph land. This beautiful species when in breeding-plumage has a black collar but no hood, the underparts being tinted with a rich rose-colour, whilst the centre feathers of the tail are somewhat prolonged as in the Skuas, from which group, however, it is in all other respects far removed. This also is an Arctic species with no near allies. The last of the Arctic species is *Xema sabinii*, a gull but slightly larger in size, with a black hood deepening into a collar, and a *forked* tail. This gull breeds right round the Arctic circle from Greenland to the Siberian tundras north of lat. 74°, and has been known to push its southern migrations as far as the north of Peru. There is considerable interest attaching to this wanderer in the tropical Pacific; for at Chatham Island, one of the Galapagos group, and situated nearly on the Equator, was obtained one of the two existing specimens of that rarest of all gulls, *X. furcata* (Neb.)—a fork-tailed hooded species, which, but for a few trifling details, is a gigantic *X. sabinii*. Over the real habitat of *X. furcata* there hangs a slight mystery. There can be no doubt the specimen in the British Museum was obtained in the Galapagos group, the very rock (Dalrymple rock,

Chatham Island) is indicated ; the plumage seems to be that of maturity, and the date accords with what that plumage ought to be. The other specimen, which is in the Paris Museum, is stated by Nebois to have been obtained at Monterey, California, during the cruise of the 'Vénus'; but that frigate also visited the Galapagos, and there may be a mistake in the locality, as Mr. O. Salvin has shown that such errors have occurred with other birds. This supposition is favoured by the fact that the American naturalists have kept a keen but unavailing look-out for it during many years past ; and as the Galapagos group is seldom visited except by whalers and an occasional British man-of-war, it seems probable that this is another of those forms which are not merely confined to that archipelago, but even to a few islands of it. Under these circumstances it is interesting to find that its nearest ally comes at times so close to its domain ; and this approximation in the Pacific is another link in the chain of evidence respecting the centre of dispersion.

These Fork-tailed Gulls lead in a manner to the subfamily of Terns (*Sterninæ*), although there is a tolerably wide gulf between them, as shown by the shape of the bill, the short feet and tarsi, and the long wings, the latter pointing to increased adaptation for prolonged flight. Accordingly we find that, as a rule, there are fewer specialized forms than in the *Larinæ*, and that the range of the majority of the species is wider than in the same proportion of the Gulls. This is mainly due to the conditions of their existence, which depend on fish and aquatic productions ; but even under conditions so favourable to dispersion, there are not wanting some remarkable instances of isolation. Of the larger and heavier species, the largest, *Sterna caspia*, although nowhere numerically abundant, has an immense range, being found breeding from the Nearctic and Palæartic regions down to New Zealand, although replaced throughout intertropical America and on the west coast of Africa by the somewhat smaller and more elegant *S. maxima*, Bodd. *S. cantiaca* has a western Palæartic and eastern Nearctic range, going to the Cape of Good Hope in winter, as do also both *S. fluviatilis* and *S. macrura*, Naum., our Common and Arctic Terns, which have a more extended range in the north, whilst none of them are known to breed in the southern hemisphere. From the Mediterranean to the Malay Archipelago and Torres Straits is found *S. media*, the Old-World representative of *S. elegans* and *S. eurynathus* of tropical America ; whilst from

Africa to Australia and Polynesia we find a large Tern only differing from the usual style of coloration in having a white frontlet band at the base of its bill, and which, in spite of local variations in size and colour of mantle, seems to me to be but one species, *S. bergii*, Licht. It would be tedious to enumerate all the typical species and to give their respective ranges; but there is a point in the distribution of some of those in the southern hemisphere which must not be passed over. On the coasts of Chili, the Straits of Magellan, and the Falkland Islands is found *S. hirundinacea*, Less. (*L. cassini*, Selater), rather larger than our Common Tern, *S. fluviatilis*, and having a bright red bill. At Tristan d'Acunha, and thence to St. Paul's and Amsterdam Islands, and down to Kerguelen Island, we find a very similar Tern, *S. vittata*, Gm., but smaller and with the underparts washed with grey, closely resembling, in fact, our Arctic Tern, *S. macrura*, but having a longer tarsus. The Tristan d'Acunha bird is undoubtedly *S. vittata*; but its connexion with *S. hirundinacea* is shown by a visibly closer approach to that species than is the case in St. Paul's or Kerguelen-Island examples. At Kerguelen Island is also found an affined but quite separable species, *S. virgata*, Cab., of a more uniformly sooty hue, but still presenting the characters of an *oceanic* tern in its pointed red bill and elongated tail-feathers; this species is absolutely confined to that island. Passing to New Zealand, we meet with very similar species, *S. antarctica*, Wagler, in which the shape of the bill is somewhat modified, becoming short, stout, and considerably curved in the upper mandible, the webs of the feet are also more excised—peculiarities which have led to its being placed by some systematists in the genus *Hydrochelidon*, with which, however, it has no real affinity. Here the chain breaks abruptly, there being beyond this point no connexion with South America to complete the circle. As the northern representatives of these Antarctic species come down, in winter at least, as far as South Africa, the point of union seems in this case to be the South Atlantic; but when and why the separation took place in their breeding-range it is impossible to say. New Zealand also possesses one isolated species, *S. frontalis*, a rather larger Tern with a white frontlet, apparently more closely connected with *S. cantiaca* than with any other.

From the Red Sea to the Laccadive Islands is found another of these specialized forms, *S. albigena*, a slender species of the Common Tern type, but washed all over with a sooty hue. Another mem-

ber of the same group, *S. dougalli*, has a very wide range, reaching from temperate America and Europe to South Africa, Ceylon, and the Andaman Islands, where it breeds, even to the northern coasts of Australia. All these are typical species so far as shape and the black crown to the head are concerned; but from China and the Andamans to Torres Straits and Eastern Polynesia we find *S. melanauchen*, an oceanic species which has only a black band from the lores to the nape, the crown being white; this, again, is an isolated form. In South America, from Brazil to Chili, there is another species, *S. trudeaui*, which is singular in having no crest, but only a dark streak from the eye to the ear and a party-coloured bill.

Of the group of Little Terns, of which *S. minuta* is the type, there are several species, respecting which it need only be said that the variations comprise the typically marked *S. balænarum* of South Africa, with a full black crown with white lores, *S. minuta*, with only a partially black crown with black lores, and *S. nereis* of Australia, with uncoloured lores and a partially black crown. Their distribution gives no clue to their point of dispersion. Neither are the three species of Marsh-terns comprised in the genus *Hydrochelidon* of much use; they are probably Old-World forms, having a wide range north and south. Only one, the Black Tern, *S. nigra* (L.), is found in America as well as in the Palæartic region, the other two, *H. hybrida* and *H. leucoptera*, ranging as far as Australia and New Zealand. *Sterna anglica*, placed by some systematists in the genus *Geochelidon*, and the River-terns, *S. seena* of India and *S. magnirostris* of Tropical America, need no special remarks.

Returning once more to the North Pacific, we find a remarkable and very local form in Alaska, *S. aleutica*, which has a white frontlet, black lores, a dark crown, and a dark grey mantle, the underparts being washed with grey. Looking at the head alone, it presents the markings of one of the group of Sooty Terns which have been placed by Wagler in three distinct genera, *Onychoprion*, *Haliplana*, and *Planetis*, all based upon the same identical species! It differs, however, from all Sooty Terns in having the rump and tail pure white, in which respect it resembles the bulk of the Nearctic and Palæartic species, whereas in the Sooty Terns the rump and tail are dark like the mantle. At present it is separated by an interval of upwards of 20° of latitude from any of the Sooty Terns, of which there are three species, all wide-ranging and intertropical; but it is impossible to avoid considering it an important link in the chain of descent, the other com-

ponent parts of which are missing. This view is strengthened when it is observed that from the Moluccas throughout part of Polynesia is found its nearest ally amongst the Sooty Terns, namely *S. lunata*, a species in which the upper parts are dark grey instead of black as in *S. fuliginosa* and *S. anæsthera*. Here, again, the Pacific seems to be the point of departure.

On the coasts of Peru and Chili is found a very remarkable species, *Nænia inca*, typical as regards its forked tail, but raised to generic rank on account of its long, curved, projecting feathers resembling moustaches, and the union of the foot with the hallux. It is believed to be a rock-breeding species, but little is known about it. A still more highly specialized form is the snow-white *Gygis*, which has long slender toes, with deeply excised webs, and a graduated tail, the second or third feathers being the longest, in which respect it is allied to the Noddies (*Anous*). *Gygis candida* ranges from Ascension, St. Helena, Madagascar, Mauritius, &c. to Australia, and thence through Polynesia up to the Sandwich Islands: at the Marquesas is also found a smaller and slender-billed form, which I consider entitled to specific distinction, *G. microrhyncha*. The nidification in this genus is very peculiar, the single egg being placed in any trifling depression in the surface of the branch, or in a fork of a tree or even of a stout plant. In making no nest these birds resemble the majority of the *Sterninæ*; but the shape of the tail points to a relationship with the members of the genus *Anous*, the nearest being with the two small grey Noddies, *A. cæruleus* (Bennett), and *A. cinereus*, Gould, which appear to be almost if not entirely confined to the coral-islands of the Pacific, where they deposit their single egg in the crevices of the rocks, making no nest. Next comes a nearly black Noddy with a white crown, *A. leucocapillus*, Gould, confined to the islands between the Paumotu group and North Australia, which also seems to make no nest. The record respecting these and the two following species is, however, very imperfect, and it is not safe to base any deduction upon what is at present known of their distribution. *A. melanogenys*, Gray, with deep black lores and greyish nape, is a widely-distributed species, being found from Honduras down to Australia and Polynesia. The most remarkable fact about its range is that the 'Challenger' Expedition obtained it at Inaccessible Island close to Tristan d'Acunha, in 37° S. lat., the home of the penguin, the albatross, and other sub-antarctic species, where the even more widely-diffused Common

Noddy, *A. stolidus*, was also found. These two species make a substantial nest of seaweed, and place them on trees, bushes, and rocks. Of *A. tenuirostris* (Temm.), I can only say that it seems to have been obtained at Senegal, the islands of Rodriguez and Mauritius, and the west coast of Australia: it differs from *A. melanogenys* in having grey lores and face; but much more information is requisite respecting it before its range can be mapped out with any approach to accuracy.

Of the Skimmers (*Rhynchopsinæ*), which have the general appearance of Terns with a remarkable projecting under mandible, there are three species separable by their plumage alone. In habits and nidification they are alike, frequenting the banks of large rivers, and depositing their eggs on the sand. The most distinct is naturally *R. nigra* of Tropical America; *R. flavirostris* of Egypt and the Red Sea, and *R. albicollis* of India, being more closely related. The American species ranges from New Jersey, along both sides of America down to 45° S. lat., and its complete isolation from its two close allies is very peculiar.

It is, then, in the North Pacific that we find the majority of the typical *Larinæ*, and it is there alone that the Arctic and white-primaried forms are connected through *L. glaucescens* with the group which have distinctly barred primaries, almost all the members of which are also found there. It is only in the North Pacific that we can see where the three-toed *Rissa* began to deviate from the typical four-toed Gulls, and it is only there that a faint line of connexion can be traced between the only two species which have forked tails (*Xema*). It is only along the Pacific coasts that the continuous chain can be followed with the typical Hooded Gulls, of which *L. ridibundus* is the Palæarctic representative, and which in *L. glaucodes* reaches unbroken to the Straits of Magellan, whilst in the eastern hemisphere it cannot (with the solitary exception of the South-African *L. phæocephalus*) be found south of 10° N. lat. It is again only in the North Pacific that we find the peculiarly-coloured tern *Sterna aleutica*, which so clearly connects the typical *Sternæ* with the intertropical Sooty Terns, *S. lunata*, *S. anæsthesia*, and *S. fuliginosa*. It is not necessary to lay much stress upon those Pacific gulls which, with slight modifications, have barred tails at all ages and a hood in the immature stage, for there the chain is more broken; and the majority of the *Sterninæ* are also so wide-ranging that their distribution teaches

us but little, although even here the links which unite *S. hirundinacea* of South America with *S. antarctica* of New Zealand, by way of the Southern Ocean, are very interesting. The distribution of the Skuas or Parasitic Gulls seems also clearly to connect the northern and southern hemispheres by way of the Pacific. It is, in fact, easier to specify the isolated groups which have no apparent connexion with the Pacific, foremost amongst which is that comprising the New-Zealand *L. bulleri* and *L. scopulinus*, the Australian *L. novæ-hollandiæ*, and the South-African *L. hartlaubi*. In the Arctic region there are the two isolated and specialized genera of Gulls, *Pagophila* and *Rhodostethia*, which are not known on the Pacific side; whilst amongst the Terns the intertropical genera *Nenia*, *Anous*, and *Gygis*, although somewhat related *inter se*, offer no particular points of union with the typical *Sterninæ*. It is admitted that the present record is necessarily very imperfect, but it seems to me that the bulk of the evidence indicates the North Pacific as the centre of dispersal; and whether this view be accepted or not, I trust that the points to which I have drawn attention may at least show that Mr. A. R. Wallace's statement that the *Laridæ* are of little use in the study of geographical distribution is capable of a slight modification.

On the Action of Limpets (*Patella*) in sinking Pits in and Abrading the Surface of the Chalk at Dover. By J. CLARKE HAWKSHAW, M.A., F.G.S. (Communicated by Dr. J. MURIE, F.L.S.)

[Read April 18, 1878.]

(Abstract.)

THE surface of the chalk which is exposed between high- and low-water mark on the foreshore to the east of Dover is covered by a series of small and finely grooved hollows made in the substance of the chalk. These abrasions of the surface are made by the limpets when feeding on the coating of delicate seaweed which covers the surface of the chalk.

When the rock has a good coating of this seaweed, the proceedings of any single limpet may be well seen. The lingual teeth make a small scoop or groove in the chalk; and as the animal makes a number of grooves one beside the other, a line is produced. After the limpet has completed a line, which is curved